GEOLOGIC CHARACTERIZATION OF LAKE HARNEY

VOLUSIA/SEMINOLE COUNTIES, FLORIDA

By

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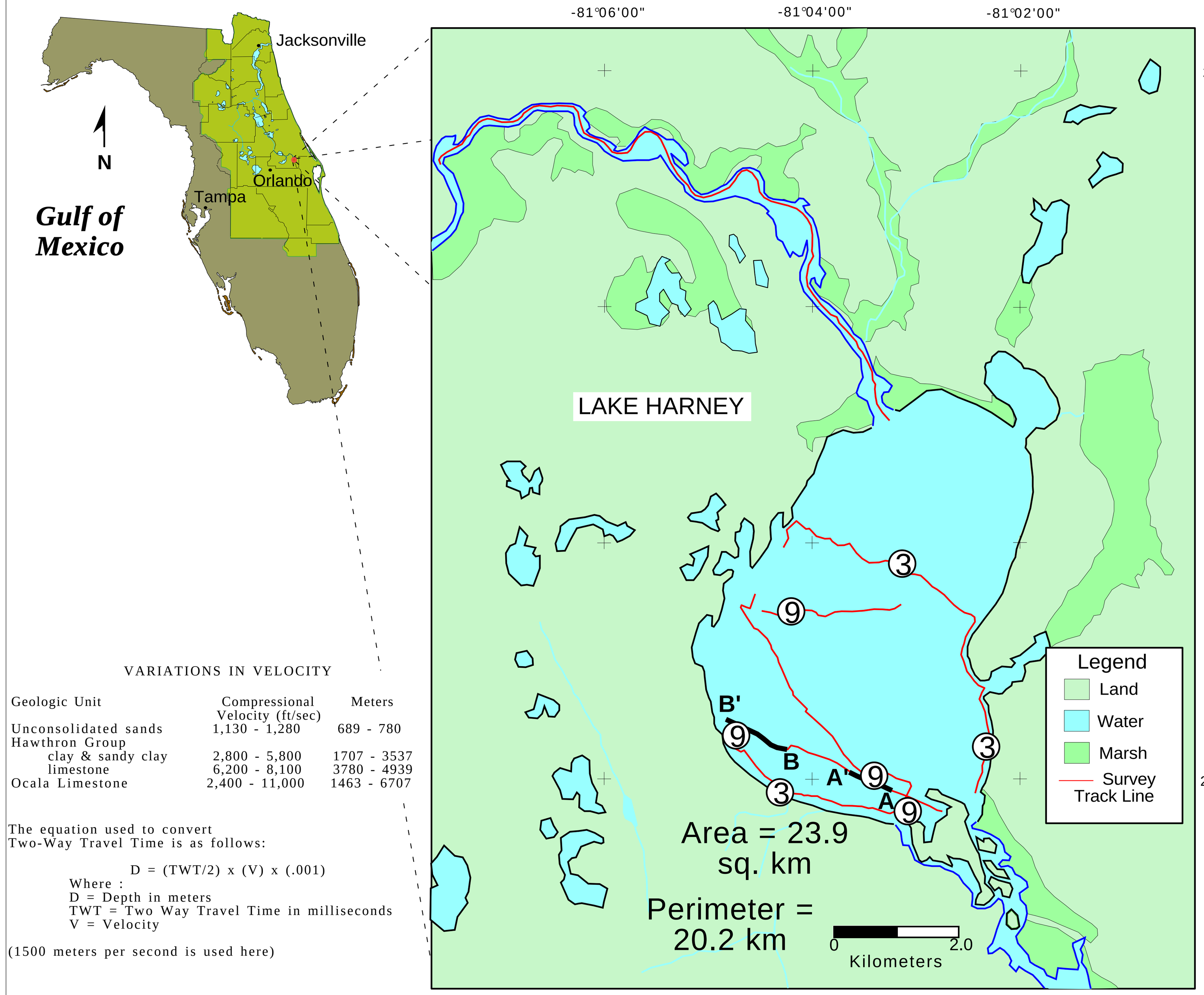


VARIATIONS IN VELOCITY

Geologic Unit	Compressional Velocity (ft/sec)	Meters
Unconsolidated sands	1,130 - 1,280	689 - 780
Hawthron Group		
clay & sandy clay	2,800 - 5,800	1707 - 3537
limestone	6,200 - 8,100	3780 - 4939
Ocala Limestone	2,400 - 11,000	1463 - 6707

The equation used to convert Two-Way Travel Time is as follows:

$$D = (TWT/2) \times (V) \times (.001)$$

Where :
D = Depth in meters
TWT = Two Way Travel Time in milliseconds
V = Velocity

(1500 meters per second is used here)

INTRODUCTION

The potential fliud exchange between lakes of northern Florida and the Floridan aquifer and the process by which exchange occurs is of critical concern to the St. Johns River Water Management District (SJRWMD). High-resolution seismic tools with relatively new digital technology were utilized in collecting geophysical data from > 40 lakes and rivers. The data collected shows the application of these techniques in understanding the formation of individual lakes and rivers, thus aiding in the management of these natural resources by identifying breaches or areas where the confining units are thin or absent between the water bodies, the Intermediate aquifer and the Floridian aquifer.

This study was a cooperative investigation conducted from 1993 to 1996 by the SJRWMD and U.S. Geological Survey Center for Coastal Geology (USGS). Since 1989 there have been technical and hardware advances in the digital acquisition of high-resolution seismic data. The primary objective of this cooperative was to test newly developed digital high-resolution single-channel marine seismic continuous-profiling-equipment (HRSP) and apply this technology to identify subbottom features that may enhance leakage from selected lakes and the St. Johns River. The target features include: (1) identifying evidence of breaches or discontinuities in the confining units between the water bodies and the aquifer, and; (2) identifying areas where the confining unit is thin or absent.

METHODS

In cooperation with SJRWMD the USGS acquired and upgraded a digital seismic acquisition system. The Elics Delph2 High-Resolution Seismic System was acquired with proprietary hardware and software running in real time on an Industrial Computer Corp. 486/33 PC. Hard-copy data was displayed on a gray scale thermal plotter. Digital data was stored on a rewritable Magneto-Optical compact disk. Navigation data was collected using a Trimble GPS or PLGR (Rockwell) GPS. GeoLink XDS mapping software was used to display navigation.

The acoustic source was the Huntec Model 4425 Seismic Source Module and a catamaran sled with an electro-mechanical device. Occasionally, an ORE Geopulse power supply was substituted for the Huntec Model 4425. Power was set at 60 joules or 135 joules depending upon conditions. An Innovative Transducers Inc. ST-5 multi-element hydrophone was used to detect the return acoustical pulse. This pulse was fed directly into the Elics Delph2 system for storage and processing.

Forty-four line-km of HRSP data was collected from Lake Disston. A velocity of 1500 meters per second (m/s) was used to calculate a depth scale for the seismic profiles. Measured site specific velocity data is not available for these sites.

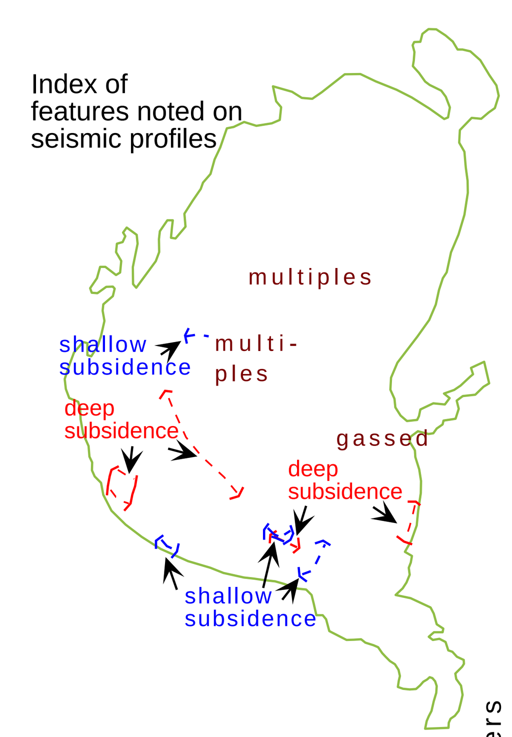
These surveys were conducted in part to test the effectiveness of shallow-water marine geophysical techniques in the freshwater lakes of central Florida. Acquisition techniques were similar but modifications were necessary. Data quality varied from good to poor with different areas and varying conditions. As acquisition techniques improved so did data quality in general. In many areas an acoustic multiple masked much of the shallow geologic data.

Physiography

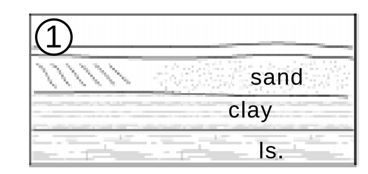
Lake Harney straddles the Volusia-Seminole county line along the St. Johns River. The lake is part of the St. Johns Wet Prairie of the Eastern Flatwoods District (Brooks, 1981). The series of lakes along the St. Johns River in this area occupy valleys previously incised by Late Pleistocene fluvial-lagoonal processes. The area is low-lying and predominantly marshland. Lake elevation at the time of the seismic survey was ~1.8 m (6 ft) NVGD. Gopher Swamp appends to the east, separated from the lake by Stone Island. Black Cypress Swamp is connected to the lake via Underhill Slough to the northeast. The St. Johns River enters Lake Harney from the south and flows out to the north. Lake Harney is roughly oval in shape, with 30 kilometers of shoreline and a surface area of about 26 square kilometers.

GEOLOGIC CHARACTERIZATION

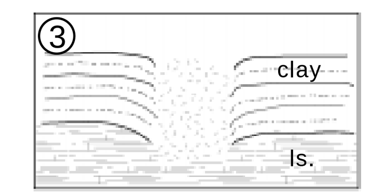
Seismic profiles from Lake Harney show a good example of subsurface karst imaging (profile A-A', B-B'). Profile A-A' shows a deep reflective surface (red line) with apparent subsidence. This feature is similar to a Type 9 feature described in the explanation. This subsidence influences the integrity of the overlying strata, as shown in subsequent collapse across another reflective surface (blue line). Profile B-B' shows another deep collapse structure (red line). Within this subsidence, horizontal reflective signals onlap the steeper sides of the structure. This could represent fluvial or aeoling infilling of the depression. This type infilling may have also occured in the shallower depresstion shown in Profile A-A', as evidenced by the patterned texture of the acoustic signal from the overlying material. This pattern could represent foresets or cross-bedding, as opposed to collapse-type infilling, which typically returns a noiser or chaotic signal. Scott, 1988 estimates the top of the Peace River Formation of the Hawthorn Group to be at about 50 to 60 feet below mean sea level in a core obtained south of the Lake. This corresponds to about the depth of the reflective surface shown by the red line.



EXPLANATION

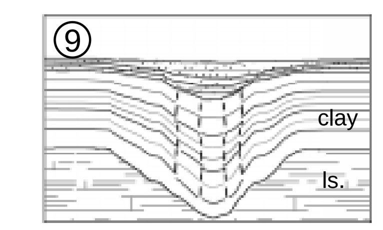


Undisturbed section, with or without upper non-reflective sand layer. Sand layer may show reflection where cross bedding from original deposition (fluvial or aeolian) exits. Clay layers are mostly intact.



Horizontal reflectors continuous on either side of a central non-reflective zone. Horizontal layers bend downward towards the central zone. These features are representative of filled collapse sinks. The size may range from tens of meters to kilometers across a lake basin.

Near vertical discontinuities through parallel, horizontal reflectors with little vertical displacement. Represents fractures or small tension faults due to overburden slumping into sinks.



Low- to mid-angle subsidence depressions. Parallel reflectors have undergone displacement and rotation, creating stress fractures and faulting within the depression. The subsidence may or may not be filled with overburden.